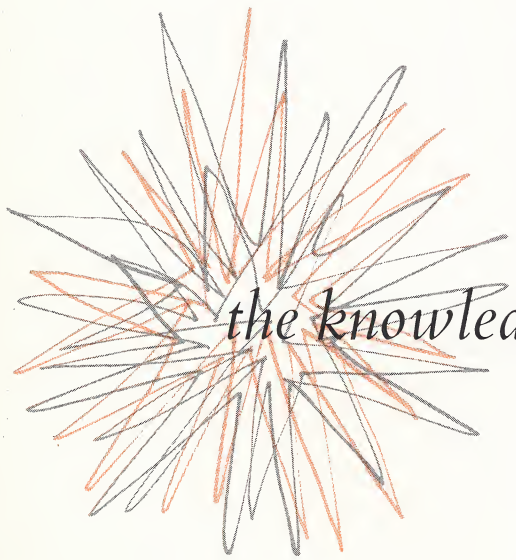
THE KNOWLEDGE AVAILABILITY SYSTEMS CENTER

UNIVERSITY OF PITTSBURGH

"*My proposal is that the University of Pittsburgh formally address itself to the problem of creating fundamentally new knowledge availability systems, experiment with their use, and ultimately pioneer in their application . . .* "—Chancellor Edward H. Litchfield on the occasion of the University of Pittsburgh's 175th anniversary, 1962.



the knowledge explosion

All the indices of twentieth century scientific and social inquiry point to the presence of a kind of Malthusian law for the growth of knowledge. Knowledge is growing at a faster rate than society's ability to assimilate it.

It has been estimated, for example, that more than 2,000 pages of texts, newspapers, reports and books currently are being published every sixty seconds of the 24-hour day. Even eliminating the trash and the transient, that still leaves many millions of pages of information which are recorded annually. This year's millions of pages must be added to last year's millions of pages and to the pages of the years before, back to the beginning of recorded time.

That this trend will continue also is indicated by two statistics reported recently by the National Science Foundation: of all the scientists and engineers who have ever lived, eighty percent are alive and working today; and, of all the world's scientific and technical discoveries, half have been made in the last fifteen years.

Since in science the most recent finding is, for the most part, the most important one, speed of collection and ease of accessibility to stored data often are more of a problem for efficient handling of modern knowledge than the volume of storage. And there are indications that the existing apparatus for collecting and retrieving already is becoming sorely strained. For example:

- In a recent issue of *Physical Review,* a Nobel laureate wrote to acknowledge "a previous publication, of which I was unaware," describing essentially the same research he had reported some months earlier.
- An article on the successful application of Boolean algebra to electrical circuits appeared in a journal of the Soviet Academy of Science in 1950, and though an English abstract later was published, it was not "discovered" until five years afterward—after several teams of mathematicians in a variety of American industrial concerns had spent more than fifteen man-years in unsuccessful attempts to solve the problem.
- The need to keep physicians up-to-date with

information concerning new discoveries in their respective fields has been cited as "our biggest problem" by a joint study committee on continuing medical education appointed by the American Medical Association, the American College of Physicians, and six other professional medical groups.

In addition to the problems of handling existing data in traditional ways, there also is a growing need, in an age where scientific knowledge is power, to do more than just gather and house information; it must be actively disseminated to those who need and can use it.

There is clearly a need for a review of the mechanisms by which knowledge is treated from the moment it is created as knowledge until it is delivered to an academic or industrial "user."

The University of Pittsburgh first addressed itself formally to this problem in September 1962. In a speech marking Pitt's 175th anniversary, Chancellor Edward H. Litchfield called for study along four major lines.

"1. New knowledge is transmitted too slowly. The classical process of research, writing, publication, and distribution is no longer adequate in a great many fields in which we presently work. New knowledge must be made available over tremendous areas as soon as it becomes knowledge . . .

"2. Existing knowledge is insufficiently mobile . . . We are hobbled by the equipment and technologies of earlier times . . .

"3. Knowledge in many fields has already become so vast and complex that often we do not know what we have, and when we do know that certain information exists, we are unable to find it . . .

"4. As knowledge burgeons, the patterns of relationship short of broad philosophic systems become increasingly difficult to comprehend. We urgently need the means to relate vast quantities of knowledge to one another so that those patterns may become discernible to the thinking, researching, practicing professional person . . ."

It was for these reasons, and to these ends, that the University established in August 1963, an interdisciplinary Knowledge Availability Systems Center.

the KAS center

THE GOVERNING PRINCIPLE behind the Knowledge Availability Systems Center (KASC) is that, while vast expenditures of time, effort and money are being made on the content of knowledge, much of this knowledge stands in danger of becoming strangled in its own volume and never realizing its potential contribution to society unless new *forms and procedures* for dealing with it are devised.

What are the routes that basic research findings take when they are "spun off" into practical industrial applications, and how can they be improved?

Can materials produced for the publishing industry be channeled to users of scientific texts in other ways?

What is the optimum format for presenting different kinds of scientific information to various technical groups?

Are the present methods for storing and retrieving data in the library adequate?

These are the kinds of questions the KASC will attempt to answer.

KASC is concerned with all of the various mechanisms and concepts governing the recording, storage, retrieval, transmission and dissemination of knowledge. Its investigations range across such fields as logic and language, publication procedures, library and record storage, information retrieval and media studies, and all other techniques, both advanced and mundane, for handling information.

The Center also postulates a new role for the information scientist in society. In addition to upgrading his traditional function as a caretaker of knowledge, it hopes to impose on him a new responsibility for actively disseminating it. In short, it is no longer sufficient to harbor information and retrieve it on request; information must be distributed to those who can use it regardless of whether it is asked for or even whether the potential user is aware of its existence.

The center serves as a locus within the University to bring a range of academic talents to bear on such problems. Specifically, the Center has three functions—to conduct research on the development and evaluation of systems, to operate new systems and to teach the use of such systems within the several disciplines and professions where they can be employed effectively.

Faculties from the substantive areas of study within the University contribute to the Center bodies of information—the raw material for research on criteria and evaluation procedures. Philosophers, logicians, and linguists will help the Center to investigate the basic nature of language as a medium for communicating thought. Behavioral scientists will contribute advice on political, economic, and sociological factors that affect patterns of communication. And specialists in library science, industrial engineering, education, business management, and computing and data processing work with the Center's staff in the design of evaluation investigations.

In addition to its own full-time staff, the Center works with faculty and staff on joint projects in the Department of Industrial Engineering, School of Education, School of Medicine, Divisions of the Natural Sciences and Humanities, Crystallography Laboratory and Department of Philosophy. The Computation and Data Processing Center, another central facility of the University, also is actively involved in the work of KASC.

The Center itself has offices in both the Hotel Webster Hall and the University's Space Research Coordination Center, established by a major grant from the National Aeronautics and Space Administration, and will have research facilities in the new Hillman Library.

In addition to its intra-University associations, the Center also is working on various projects with the Veterans Administration, the University of Akron, the National Institutes of Health, and with the White House advisory staff on the development of plans for a national automated science library system.

Also, the Center, through a cooperative program with the National Aeronautics and Space Administration, is developing retrieval systems for and providing space-related information to a number of companies in the oil, metals, plastics, gas, electric, banking and other industries throughout the Western Pennsylvania region.

research

KNOWLEDGE AVAILABILITY represents, in effect, a new research sea. It is a sea whose shores were not even described a few years ago. Inevitably, as organized exploration begins, the first efforts are to construct charts and rudders.

KASC research projects currently are underway or contemplated in six major areas—criteria for systems design, comparative study of systems, language manipulation, behavioral studies, hardware studies, and studies of media.

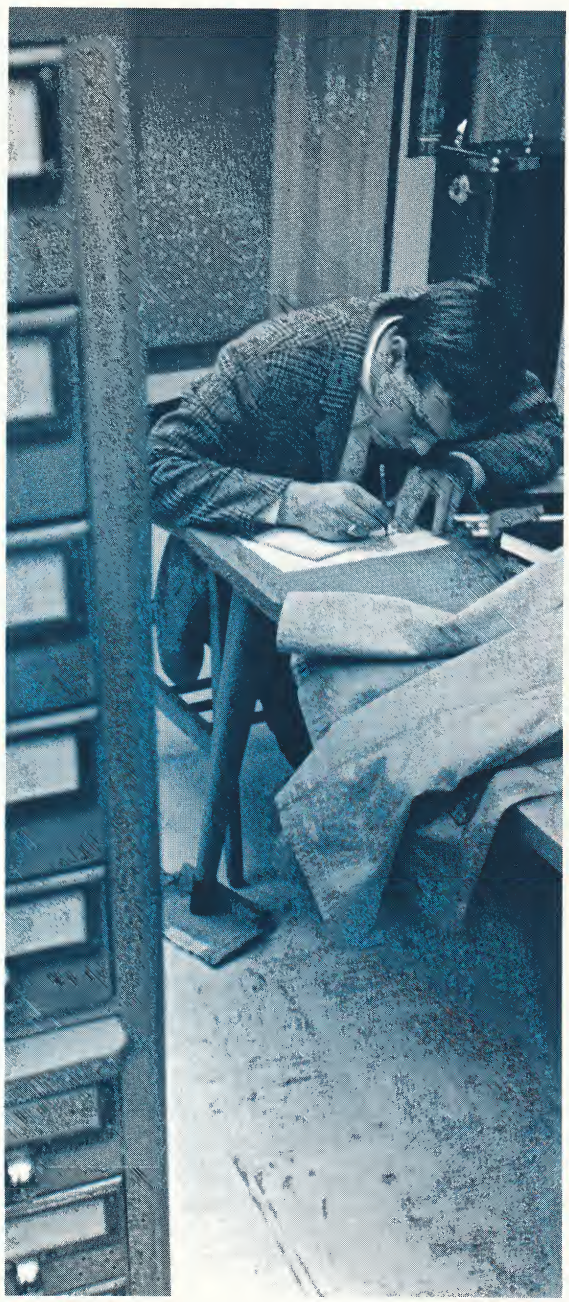
The Research is conducted by members of the Center's staff, by joint appointees, by faculty from other departments, and by doctoral students and interns in KASC from a variety of disciplines.

- *Criteria for systems design*—Essentially this research is concerned with finding out what kinds of functions knowledge availability systems ought to have and how such systems ought to be constructed to carry out specific tasks. This cannot, of course, be done in a vacuum, Therefore, hand-in-hand with establishing criteria, the Center is attempting to identify those bodies of information which, because of the volume of data available or some special need for speed and precision of retrieval, are most susceptible to organization. Among the fields in which the Center is now working are space exploration, rubber chemistry, and medicine.

- *Comparative studies of systems*—There are many possible components to a knowledge availability system. The recording of data can be done on the printed page, on computer tape, on a cathode ray tube, or in the form of a punched card. The information may appear in ordinary language, in special mathematical languages, or in some conglomerate form. Texts can be stored in their entirety, or only index and reference points may be filed. Retrieval might be done by a computer, by some specially devised machinery, or by a winsome lass in flat-heeled shoes with a stepladder and a library card. Delivery systems are equally various. And each component can be mixed or matched with any other to create an infinite number of combinations.

The comparative studies of systems are concerned, essentially, with three basic questions:

Which systems work best under what kind of circumstances of material, equipment and audience?



How reliably can systems be made to perform in terms of accuracy, consistency and completeness of information retrieved?

What are the factors affecting the cost and economy of any given system?

• *Language manipulation*—Communication occurs in many ways and on many levels. Language, although the predominant form, is only one means of communication; it doesn't encompass the many unarticulated circumstances in which meaning is expressed. But even language, with its nuances, multiple interpretations, and vagueness is not readily susceptible to systemization.

This problem is complicated further in a knowledge availability system. The language in which data are recorded might be the natural language of a researcher's report; it might be only a title, chapter heading or index number; or, it may be the paraphrasing of an abstract. If a computer is part of the system, then another language is involved—either a numerical language or one of the crypto-mathematical languages designed for machine use. A final language problem occurs in the output of the system: it must be designed to assure that the language of the user—that is, the way the questioner phrases his query—is the correct one for triggering an adequate response.

These are some of the components of KASC's researches on language manipulation. Testing will be done on natural and artificial languages, numerical and non-numerical information, on the relationships between them, and on other means of expression. The Center hopes thereby to identify standards and variables for language used in a variety of knowledge availability systems.

• *Behavioral studies*—People have varying orientations, backgrounds, and prejudices, whether they are aware of them or not. Some of these peculiarities are specific to individuals, others are common to groups. But one way or another, they affect the design of knowledge availability systems. There

is already some evidence, for example, that the neuroses of a person suffering from mental disorders may influence the way he records and catalogues data. And a researcher in the humanities is likely to approach a knowledge availability system in a different way from an engineer.

Through controlled and free-association testing, and with a special information retrieval game devised by the staff, KASC hopes to uncover some design precepts that will enable systems to be tailored to specific audiences.

Another aspect of these studies concerns the relationship between knowledge availability systems and programmed learning. The former are concerned with the storage of knowledge in a logical pattern and the retrieval of data in a desired arrangement. Programmed learning, too, deals with a body of knowledge and its presentation in small, precise steps that gradually increase understanding and retention of the material. The possibility exists, therefore, that a knowledge availability system can be called on to supply information in programmed form for instruction.

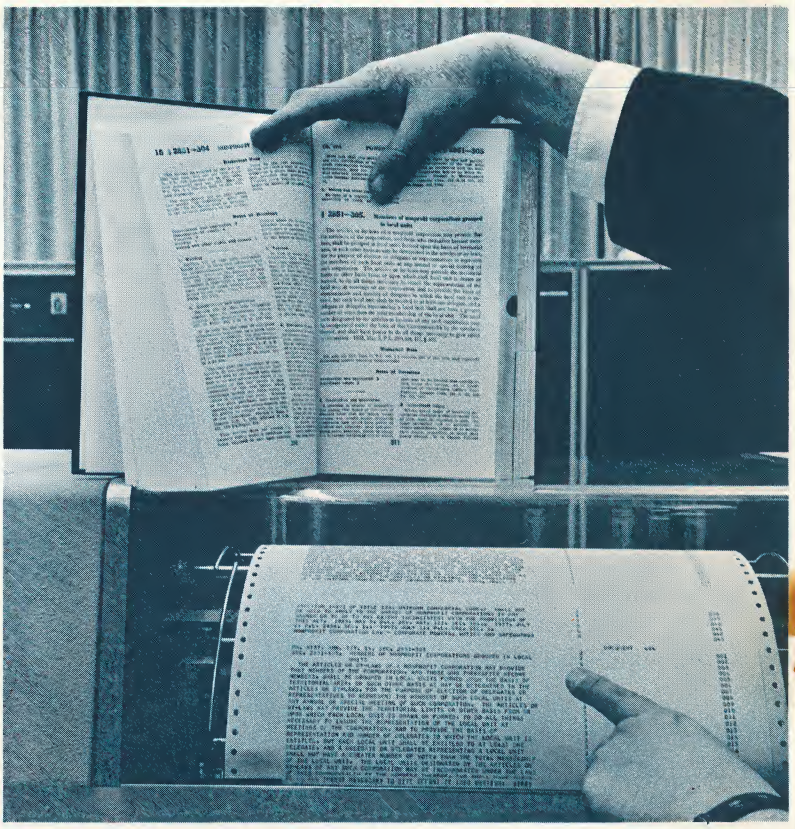
A third part of this research is involved with investigating the desirability of centralized versus decentralized information centers, and general versus specialized knowledge availability systems. Again, patterns of human behavior must be examined: Would scientists be better served by one complete storage location for data in their field, or would many such locations scattered across the country be more useful? What would be more useful to the space researcher—separate centers devoted to the various disciplines or one center embodying information from several sciences concerned with space exploration? Which kinds of centers are more economical to establish? Who will use them?

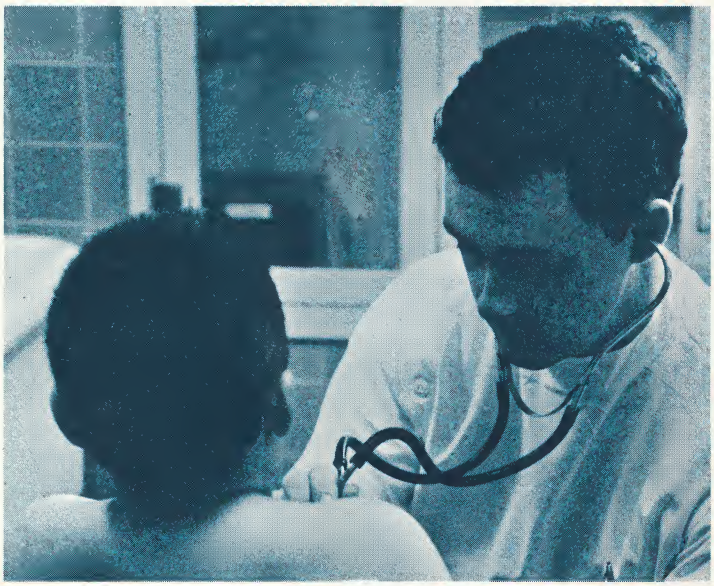
Field studies at existing centers and attitude surveys of users prior to the establishment of new centers will attempt to answer some of these questions.

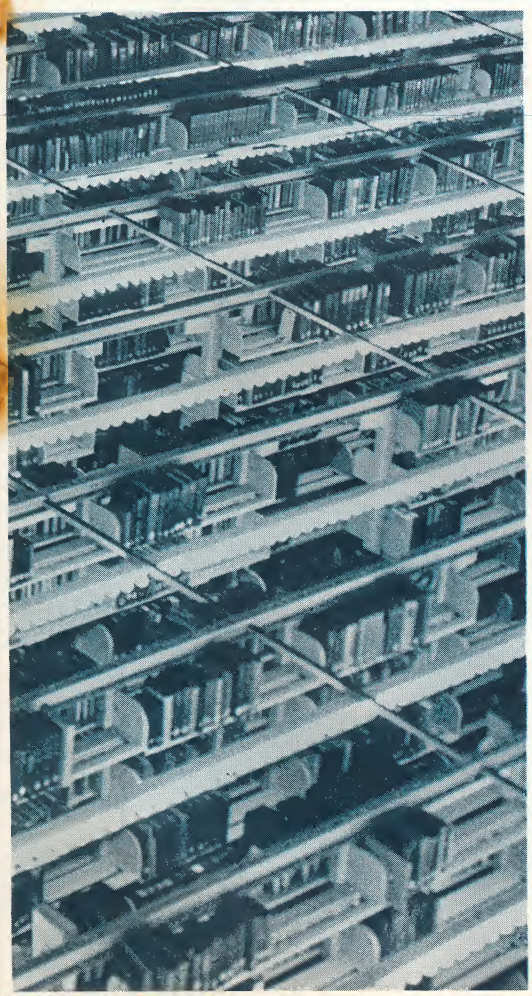
- *Hardware studies*—Information centers and knowledge availability systems have adapted much existing equipment for their special use—in particular, computers. Now as the problems of information retrieval become more acute in society, special equipment is being devised for the field. KASC will attempt to evaluate the capabilities of both new and existing equipment, determine how components can be put together into automated systems, and explore how various systems affect the kinds of literature research that can be conducted on them. Included in these studies will be analyses of the economics of various kinds of hardware and analyses of their ability to handle various kinds of data.

A key facility for hardware studies at the University is the Computation and Data Processing Center, which is available for use by researchers in KASC. At the heart of the computation center's equipment are IBM 7070 and 7090 systems, each with its own satellite 1401 computer. The computation center also has a Programmed Data Processor, and a variety of plotters, calculators, keypunches, Flexowriters and tabulators. More recently, a Photon typesetter has been acquired which will permit computer-controlled typesetting.

- *Media studies*—The usefulness of information supplied by a knowledge availability system frequently is affected by the method, or medium, for delivering it to the user. The method of presentation also affects the design of the system. KASC will investigate what media work best under various circumstances. For example: Is a permanent record required, as in the case of the scientific user who plans to refer repeatedly and over a period of time to the same information? Or is only a single fact needed at the instant, such as the one a physician might require for a diagnosis? If the user needs a record, must it be a large-size hard copy record, or will a miniaturized photograph do? These and other considerations are part of KASC's media studies program.







operations

IN ORDER to teach and conduct research on knowledge availability systems, KASC also is involved, either directly or on a consulting basis, in the establishment of a number of functioning systems.

Several such projects currently under development are indicative of the range of operational efforts undertaken by KASC:

• *NASA "spin off" project*—The National Aeronautics and Space Administration has awarded KASC $150,000 for the first year of operations of a program designed to reduce the gap—often years long—between the discovery of new scientific information and its adoption by industry. KASC is developing a regional facility to "spin off" findings from NASA-sponsored research into the area economy. The Center is evaluating data from all current NASA experiments, and the University's Department of Industrial Engineering is simultaneously classifying the relevant activities of industries participating in the program. The aim is to discover earth-bound and economically stimulating uses for the space research data. One feature of the program will be 24-hour service for answering technical inquiries from companies who subscribe.

A number of business firms already have provided

support for the "spin off" project. Among them are Aluminum Company of America, Gulf Research and Development Company, Jones and Laughlin Steel Company, Koppers Company, Inc., National Steel Company, Pittsburgh National Bank, Pittsburgh Plate Glass Company, Pittsburgh Steel Company, Shenango Furnace Company, United States Steel Corporation, Westinghouse Electric Corporation and Wheeling Steel Corporation.

- *National science library system*—Center personnel have been consultants on the development of a plan for a national system of automated libraries of scientific and technical information. The plan, formulated by the White House advisory staff, currently is under consideration by a task force of the U.S. Office of Science and Technology.
- *Diseases Documentation Center*—KASC also will serve in an advisory capacity to the School of Medicine in the establishment of a system of data collection, recording, tabulation and publication embracing all recognized symptoms and signs relating to definitive illnesses or disease states. The Diseases Documentation Center, as it will be called, will serve as a basis for reorientation of patient care, and will support research and training relating to the diseases covered.
- *Pharmaceutical information service*—KASC staff members serve on the advisory committee for a current School of Pharmacy project to develop a prototype system for electronically recording, storing, and retrieving data on physicians' drug prescriptions. A grant from the U.S. Public Health Service finances the project. The aim is to develop a model system that might be applied nationally. A national knowledge availability system for data contained on prescription forms would enable federal and state authorities to maintain complete and accurate records of drug distribution, investigate pattern of usage, and recall drugs from the market in the event of an emergency.
- *Theater arts*—A retrieval system for ephemeral material of the theater—i.e., programs, posters, magazines, etc.—is being planned in cooperation with the University's Department of Speech and Theater Arts.
- *Specialized information centers*—Research and writing have been completed for a textbook on the subject of specialized information centers for a variety of academic, scientific and engineering disciplines.

teaching

A VITAL PART of KASC's job is the design, introduction and operation of instructional programs at the graduate and postdoctoral level. Course work and seminars relating to these programs are offered through the Graduate School of Library and Information Sciences, the Schools of Engineering and Mines, the Graduate School of Business, the Computation and Data Processing Center and in the Departments of Mathematics, Psychology, Sociology, and Philosophy within the Division of the Academic Disciplines.

Closely tied with the course work are research studies leading to the doctoral degree. KASC plans to offer a number of internships as well as research associate appointments to graduate students who wish to specialize in some aspect of information science. Interns and research associates will conduct studies relating to some aspect of knowledge availability systems, and otherwise assist the Center in the research, design, and operation of knowledge availability systems.

The Center also implements its instructional function through joint appointments with schools and departments dealing with the substantive areas of study; through the appointment of distinguished visiting professors and researchers, and through seminars, workshops, lectures, conferences, and other programs of a continuing educational nature.

In the first two years of operation, seven new three-credit courses in the information sciences will have been introduced into the University curriculum under the auspices of KASC. More than 250 students enrolled for the first course; three master's theses were prepared through the Department of Industrial Engineering, and three doctoral dissertations were in process through the School of Education, the Graduate School of Public and International Affairs, and the Division of the Natural Sciences.

The courses offered were: Mechanized Information Retrieval / Specialized Information Centers / Computers and Information Retrieval / Mathematics in Information Storage and Retrieval / Language Engineering / Research Problems in Information Sciences / Data Processing and the Library

administration and staff

THE Knowledge Availability Systems Center is administered by a Director with the assistance of a Program Review and Steering Committee composed of representatives from the faculties of the several disciplines and professions of the University.

Its staff consists of full-time investigators, along with senior faculty who contribute to teaching, research and direction of programs on a part-time basis. Graduate students and interns also contribute to the Center's activities.

funding

THE Center was inaugurated with financial support from the University. Subsequently, KASC has received grants for specific projects from the National Aeronautics and Space Administration, the National Institutes of Health, and the U. S. Office of Education. Research support is sought from government agencies, foundations, and industry. In addition, specific programs of research and development will be supported by users of the Center's services from government, industry and education.

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